Appendix G

Accelerated Natural Gas Depletion Rates

Recent reports have emphasized that the decline in the rate of production from natural gas wells has increased in recent years. In *Depletion: The Forgotten Factor in the Supply Demand Equation: Gulf of Mexico Analysis*, David Pursell cites the increase in the rate of decline in natural gas production per well from less than 20 percent per year in 1970 and 1971 to 49 percent per year for wells completed in 1996.[24]

In Pursell's analysis, the increased rate of decline in the wells of the Gulf Shelf is attributable to the cumulative effects of depletion:

> *It should be no surprise that exploration and development opportunities diminish over time in a mature basin. We believe that the broad application of 3-D seismic and horizontal drilling technologies in the early 1990' s may have actually accelerated the decline rates. 3-D seismic allowed the geologists and geophysicists to "see" smaller structures that were previously not readily visible on conventional 2-D seismic. Horizontal drilling technology allowed many of these smaller reservoirs to be developed from the existing platforms with fewer wells, creating an illusion that technology was making it easier to exploit oil and gas on the GOM shelf. However, once the "low hanging fruit had been picked," the 3-D seismic technology was driving exploration of smaller (marginal) reservoirs.*

Data from natural gas wells in the Federal offshore Gulf of Mexico show an increase in the rate of decline after a well's peak. Wells drilled in 1996 are declining more quickly than wells drilled in 1972 (see Figure 4 in Chapter 1). Twenty-three months after reaching peak production in January 1997, the average production from natural gas wells that began producing in 1996 was 69 percent lower than it had been at its peak. In contrast, the decline in production over the 23 months after wells drilled in 1972 had reached their peak production was only 39 percent.

While the rate of decline from the peak appears to be increasing, that is only part of the story. The increase in decline rates has been accompanied by an increase in the peak rate of the average well's production. Average production from wells drilled in 1972 peaked at 4.2 million cubic feet per day. Average production from wells drilled in 1996 peaked at more than 6 million cubic feet per day. The trends toward higher peak production and faster decline from peak rates are apparent (Table G1.)

While wells are being developed in smaller fields than they have been in the past, they are also producing more quickly. The faster decline rate in the late 1990s is due not only to smaller fields but also to an increase in initial flow rates as the resources are developed more rapidly. Faster decline rates reflect the choice of producers to develop larger wells, as well as the underlying geology and the ongoing process of moving from the "low hanging fruit" to resources that are smaller and more difficult to recover.

The NEMS OGSM uses decline rates indirectly. The effect of increased well sizes drawing down smaller fields, which shows up as higher decline rates in Pursell and similar analyses, is modeled by reducing the amount of oil or gas that is added to reserves with each exploratory well drilled and increasing the fraction of the proved reserves that are produced each year.

The production-to-reserves ratio for natural gas varies between the Reference Case and the Accelerated Depletion Case (Figure G1).The ratio of natural gas produced to the level of proved resources is higher in the Accelerated Depletion Case than in the Reference Case. The ratio of production to proved reserves increases as depletion reduces the resources left to be developed. However, this ratio does not measure the ratio of

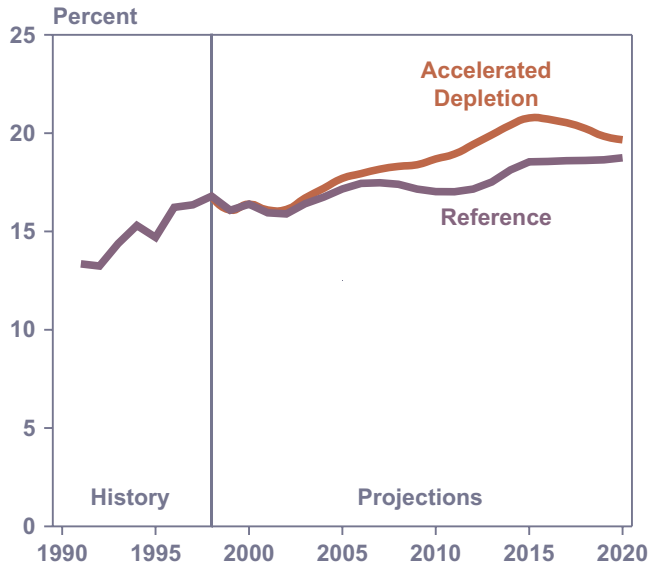
Table G1. Average Production from Wells in the Federal Offshore Gulf of Mexico, 1972 to 1996

Year	Peak Production (Thousand Cubic Feet per Day)	Percentage of Peak Production 23 Months Later
1972	4,198	0.633
1976	5,591	0.648
1980	5,533	0.502
1984	4,477	0.591
1988	4,915	0.497
1992	5,294	0.417
1996	6,070	0.314

Source: Energy Information Administration, Office of Oil and Gas, Reserves and Production Division (Dallas, TX).

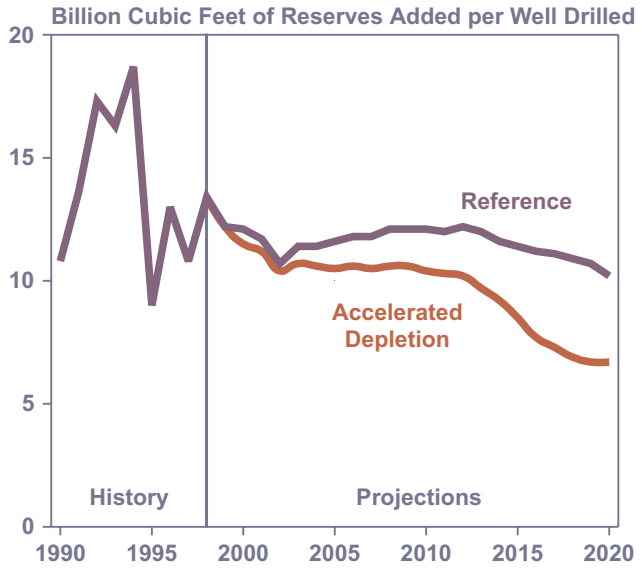
[24]David Pursell, *Depletion: The Forgotten Factor in the Supply and Demand Equation: Gulf of Mexico Analysis* (Houston, TX: Simmons and Company International, 1998), p. 10.

Figure G1. Ratio of Offshore Lower 48 Natural Gas Production to Proved Reserves, 1991-2020



Source: Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL. D051200A.

Figure G2. Finding Rate per Well for Offshore Lower 48 Natural Gas, 1990-2020



Source: Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL. D051200A.

production to the total remaining resources in a region, and therefore the production-to-reserves ratio is not a direct measure of depletion.

The finding rate, or the average amount of natural gas added with each successful exploratory and development well, is higher in the Reference Case than in the Accelerated Depletion Case (Figure G2). While the projected amount of natural gas added per well in the offshore lower 48 falls by nearly 2 billion cubic feet per successful well between 1999 and 2020 in the Reference Case, the decline in the projected finding rates in the Accelerated Depletion Case is 5.5 billion cubic feet, or nearly three times greater.

In the Accelerated Depletion Case, wells with higher production-to-reserve ratios are used to develop smaller reservoirs of oil and gas than in the Reference Case. These factors are consistent with the expectation that decline rates in the Accelerated Depletion Case will be more rapid than decline rates in the Reference Case. As other analysts have found, the effects of depletion in years to come will require more domestic drilling than there is today if domestic production is to meet or exceed the current level. Depletion is accounted for in NEMS and influences projections in the Reference Case. The more pronounced effects of depletion assumed in the Accelerated Depletion Case lead to different projections than in the Reference Case, demonstrating how stronger-than-expected effects of depletion can lead to higher prices and lower production.